State Board of Education Approved
October 2001

PRINCIPLES OF MACHINING AND MANUFACTURING

COURSE DESCRIPTION
Principles of Machining and Manufacturing **focuses on the concepts and practices that support careers in manufacturing, industrial maintenance, metrology, automation, industrial design, or industrial support. The course introduces the technology of machining and manufacturing processes. While working as team members, students will apply leadership and organizational skills relating to designing, producing, and maintaining a product. Emphasis is placed on quality control, codes and standards, and production systems. The course is contextual by design. The course connects what is being learned to the learner's current experience, past knowledge, and future conduct. Laboratory exercises provide active and cooperative learning opportunities.**

Prerequisite(s): **Algebra I or Math for Technology II**

Recommended Credits: **2**

Recommended Grade Level(s): **1 0th or 11th**

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PRINCIPLES OF MACHINING AND MANUFACTURING STANDARDS

1.0 Students will demonstrate personal management skills.

2.0 Students will demonstrate teamwork, problem solving, and decision-making skills required for success in manufacturing-related careers.

3.0 Students will demonstrate safe practices and injury prevention and treatment in a manufacturing environment.

4.0 Students will make and interpret measurements commonly required in manufacturing processes.

5.0 Students will implement quality and statistical process control procedures to ensure and improve quality in manufacturing processes.

6.0 Students will demonstrate the appropriate use of technologies used in machining and manufacturing processes.

7.0 Students will demonstrate leadership, citizenship, and teamwork skills required for success in the school, community, and workplace.

PRINCIPLES OF MACHINING AND MANUFACTURING

STANDARD 1.0

Students will demonstrate personal management skills.

LEARNING EXPECTATIONS

The student will:
1.1 Manage time and resources.
1.2 Cultivate positive personal attitudes.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:
1.1.A Plans time necessary to accomplish an objective.
1.1.B Completes assignments within required time frame.
1.1.C Investigates available resources.
1.1.D Selects appropriate resources to accomplish an objective.
1.2.A Assesses attitudes needed for success.
1.2.B Demonstrates positive personal attitudes in class activities.

SAMPLE PERFORMANCE TASKS

- Students complete personal inventories of learning, personality, and leadership styles.
- Students participate in a manufacturing simulation. Working in teams, they progressively build effective time management and resource allocation strategies as they plan for an objective.

INTEGRATION/LINKAGES

Foundation for Industrial Modernization (FIM). *What Manufacturing Workers Need to Know and Be Able to Do: National Voluntary Skill Standards for Advanced High Performance Manufacturing*. Washington, DC: National Coalition for Advanced Manufacturing, 1995. International Technology Education Association. Manufacturing Skill Standards Council. *A Blueprint for Workforce Excellence (draft skill standards for manufacturing.)* Manufacturing Skill Standards Council, 2001. Ford Academy of Manufacturing Sciences (FAMS curriculum). Project Lead the Way curriculum. English/Communications/Writing/Reading/Problem-Solving/Teamwork skills and content.

PRINCIPLES OF MACHINING AND MANUFACTURING

STANDARD 2.0

Students will demonstrate teamwork, problem solving, and decision-making skills required for success in manufacturing-related careers.

LEARNING EXPECTATIONS

The student will:
2.1 Cultivate teamwork abilities within a diverse group.
2.2 Demonstrate problem solving and decision making abilities.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:
2.1.A Performs effectively as a team member of a in a simulated manufacturing situation.
2.1.B Works cooperatively and effectively with team members of varying backgrounds, cultures, and/or race.
2.2.A Serves as a team leader in a simulated manufacturing situation.
2.2.B Solves complex problems as a team member in a manufacturing simulation.

SAMPLE PERFORMANCE TASKS

- Students complete personal inventories of work styles.
- Students participate in a manufacturing simulation. As students work in teams, they progressively build effective teamwork, leadership, and diversity strategies. The simulations require students to make decisions and solve problems.

INTEGRATION/LINKAGES

Foundation for Industrial Modernization (FIM). *What Manufacturing Workers Need to Know and Be Able to Do: National Voluntary Skill Standards for Advanced High Performance Manufacturing*. Washington, DC: National Coalition for Advanced Manufacturing, 1995. International Technology Education Association. Manufacturing Skill Standards Council. *A Blueprint for Workforce Excellence (draft skill standards for manufacturing.)* Manufacturing Skill Standards Council, 2001. Ford Academy of Manufacturing Sciences (FAMS curriculum). Project Lead the Way curriculum. English/Communications/Writing/Reading/Problem-Solving/Teamwork skills and content.

PRINCIPLES OF MACHINING AND MANUFACTURING

STANDARD 3.0

Students will demonstrate safe practices and injury prevention and treatment in a manufacturing environment.

LEARNING EXPECTATIONS

The student will:
3.1 Use reference materials to locate safety guidelines and regulations.
3.2 Analyze safety hazards and prevention procedures for the manufacturing industry.
3.3 Perform first aid in manufacturing situations.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:
3.1.A Locates health and safety reference materials relevant to a given situation.
3.1.B Interprets safety guidelines and regulations related to specific shop practices.
3.1.C Passes with 100% accuracy, a written safety examination.
3.1.D Passes with 100% accuracy, a performance examination on machining equipment.
3.2.A Assesses potential safety hazards.
3.2.B Modifies behavior to prevent accidents.
3.2.C Initiates and implements safety procedures.
3.3.A Anticipates and responds to injury accidents.
3.3.B Demonstrates basic first aid procedures for typical shop related injuries.

SAMPLE PERFORMANCE TASKS

- As students are introduced to machining practices, they look up and apply appropriate safety standards.
- As a first step in any machining operation, students perform a safety evaluation and inspection of the work area, equipment, and personal protective equipment.
- Students practice first aid techniques on one another.

INTEGRATION/LINKAGES

Foundation for Industrial Modernization (FIM). *What Manufacturing Workers Need to Know and Be Able to Do: National Voluntary Skill Standards for Advanced High Performance Manufacturing*. Washington, DC: National Coalition for Advanced Manufacturing, 1995. International Technology Education Association. Manufacturing Skill Standards Council. *A Blueprint for Workforce Excellence (draft skill standards for manufacturing.)* Manufacturing Skill Standards Council, 2001. Ford Academy of Manufacturing Sciences (FAMS curriculum). Project Lead the Way curriculum. English//Reading/Locating Information/Health and Safety skills and content.

PRINCIPLES OF MACHINING AND MANUFACTURING

STANDARD 4.0

Students will make and interpret measurements commonly required in manufacturing processes.

LEARNING EXPECTATIONS

The student will:

4.1 Use common measurement tools to perform measurements to appropriate standards of accuracy and precision.

4.2 Interpret measurements encountered in the manufacturing workplace.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

4.1.A Selects the appropriate measurement tool for a given task.

4.1.B Makes an accurate measurement of a given object.

4.1.C Records measurements with the appropriate number of significant figures.

4.2.A Interprets recorded measurements.

4.2.B Uses given measurements to set up or adapt a process.

SAMPLE PERFORMANCE TASKS

- Students make measurements using devices such as micrometers, calipers, precision scales, electronic height gages, ultrasonic thickness gages, electronic timers, and so on.
- Students measure, record, and analyze data.

INTEGRATION/LINKAGES

Foundation for Industrial Modernization (FIM). *What Manufacturing Workers Need to Know and Be Able to Do: National Voluntary Skill Standards for Advanced High Performance Manufacturing*. Washington, DC: National Coalition for Advanced Manufacturing, 1995. International Technology Education Association. *Standards for Technological Literacy: Content for the Study of Technology.* International Technology Education Association. Reston, VA, 2000. Manufacturing Skill Standards Council. *A Blueprint for Workforce Excellence (draft skill standards for manufacturing.)* Manufacturing Skill Standards Council, 2001. Ford Academy of Manufacturing Sciences (FAMS curriculum). Project Lead the Way curriculum. Mathematics skills and content.

PRINCIPLES OF MACHINING AND MANUFACTURING

STANDARD 5.0

Students will implement quality and statistical process control procedures to ensure and improve quality in manufacturing processes.

LEARNING EXPECTATIONS

The student will:
5.1 Analyze the contributing factors to an industrial process.
5.2 Use statistical process control concepts to evaluate and modify manufacturing processes.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:
5.1.A Predicts the effect of workplace documentation on specific work.
5.1.B Determines the problem in a manufacturing process.
5.1.C Resolves the problem by applying appropriate problem-solving techniques.
5.2.A Performs basic mathematical calculations, calibrations, and measurements.
5.2.B Conducts an in-process inspection and use the information to adjust a process.
5.2.C Performs a Pareto Chart analysis.
5.2.D Traces the source of any large disparity using the following tools and concepts:
- control charts
- histograms and specifications
- variability and predictability
- shape of a distribution, measures of center, measures of spread
- interpreting a curve and plotting the X-bar and R control chart
- special cause variation

SAMPLE PERFORMANCE TASKS

- Students implement statistical process control in the context of a simulated, cross-functional team that must solve a quality problem in manufacturing.
- Students demonstrate use of a quality improvement tool such as "Plan-Do-Check-Act."
- Students complete a Pareto Chart and histogram.
- Students construct a fishbone diagram.
- Students analyze control charts and communicate their interpretations to the class.

INTEGRATION/LINKAGES

Foundation for Industrial Modernization (FIM). *What Manufacturing Workers Need to Know and Be Able to Do: National Voluntary Skill Standards for Advanced High Performance Manufacturing*. Washington, DC: National Coalition for Advanced Manufacturing, 1995.
International Technology Education Association. *Standards for Technological Literacy: Content for the Study of Technology.* International Technology Education Association. Reston, VA, 2000.

Manufacturing Skill Standards Council. *A Blueprint for Workforce Excellence (draft skill standards for manufacturing.)* Manufacturing Skill Standards Council, 2001. Ford Academy of Manufacturing Sciences (FAMS curriculum). Project Lead the Way curriculum. Communication /Mathematics/Quality skills and content.

PRINCIPLES OF MACHINING AND MANUFACTURING

STANDARD 6.0

Students will demonstrate the appropriate use of technologies used in machining and manufacturing processes.

LEARNING EXPECTATIONS

The student will:

6.1 Investigate the chemical and physical properties of materials used in manufacturing.

6.2 Demonstrate the steps involved in bench layout processes for cutting, welding, and machining operations.

6.3 Demonstrate basic proficiency in common manufacturing machining operations.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

6.1.A Categorizes materials commonly used in manufacturing by their chemical and physical properties.

6.1.B Predicts how the chemical and physical properties of a given material will impact the way it is processed.

6.2.A Devise a plan for a cutting, welding, and/or machining operation.

6.2.B Organizes and lays out equipment and materials needed for a given cutting, welding, and/or machining operation.

6.3.A Performs the following machining operations and procedures safely and correctly:

- bench grinding
- metal sawing
- drilling
- tapping
- manual tool grinding
- lathe operations
- milling
- grinding
- boring
- cutting
- welding

6.3.B Performs necessary equipment maintenance.

SAMPLE PERFORMANCE TASKS

- Students work in teams to perform various fabrication layout, cutting, welding, and machining operations.
- As team members, students develop a chart of different characteristics of materials and the effects on machining and manufacturing processes.
- Student teams are given specifications for a project and must perform appropriate layout processes.

- Students use the appropriate machining operations such as metal sawing, drilling, grinding, and so on, to complete the project laid out above.

INTEGRATION/LINKAGES

Foundation for Industrial Modernization (FIM). *What Manufacturing Workers Need to Know and Be Able to Do: National Voluntary Skill Standards for Advanced High Performance Manufacturing*. Washington, DC: National Coalition for Advanced Manufacturing, 1995. International Technology Education Association. *Standards for Technological Literacy: Content for the Study of Technology.* International Technology Education Association. Reston, VA, 2000. Manufacturing Skill Standards Council. *A Blueprint for Workforce Excellence (draft skill standards for manufacturing.)* Manufacturing Skill Standards Council, 2001. Ford Academy of Manufacturing Sciences (FAMS curriculum). Project Lead the Way curriculum. Mathematics/Physics/Chemistry content.

PRINCIPLES OF MACHINING AND MANUFACTURING

STANDARD 7.0

Students will demonstrate leadership, citizenship, and teamwork skills required for success in the school, community, and workplace.

LEARNING EXPECTATIONS

The student will:
7.1 Demonstrate dignity in work.
7.2 Participate in SkillsUSA-VICA as an integral part of classroom instruction.
7.3 Evaluate school, community, and workplace situations by applying problem-solving and decision-making skills.
7.4 Demonstrate the ability to work professionally with others.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:
7.1 Demonstrates leadership skills through exhibiting characteristics of integrity and pride in work.
7.2.A Demonstrates employability skills.
7.3 Analyzes situations in the workplace and uses problem-solving techniques to create a desirable environment.
7.4.A Participates in job shadowing in an area of the manufacturing industry.
7.4.B Manages an officer or national voting delegate campaign with Tennessee SkillsUSA-VICA.

SAMPLE PERFORMANCE TASKS

- Prepare a resume.
- Participate in various SkillsUSA-VICA programs and/or competitive events.
- Attend a professional organization meeting such as, Chamber of Commerce meeting.
- Participate in the American Spirit Award competition with SkillsUSA-VICA.
- Develop a plan of action for an officer candidate or national voting delegate.
- Participate in job shadowing or internship within the manufacturing industry.

INTEGRATION LINKAGES

SkillsUSA-VICA, Professional Development Program, SkillsUSA-VICA, Communications and Writing Skills, Teambuilding Skills, Research, Language Arts, Sociology, Psychology, Math, Math for Technology, Applied Communications, Social Studies, Problem Solving, Interpersonal Skills, Employability Skills, Critical-Thinking Skills, SCANS (Secretary's Commission on Achieving Necessary Skills), Chamber of Commerce, Colleges, Universities, Technology Centers, and Employment Agencies

PRINCIPLES OF MACHINING AND MANUFACTURING

SAMPLING OF AVAILABLE RESOURCES

CORD. *Necessary Skills Now for Manufacturing*. Waco, TX: CORD Communications, 1999.
Quirk, Michael. *Manufacturing, Teams and Improvement: The Human Art of Manufacturing*. Prentice Hall, 1998.
Wright, R. Thomas. *Exploring Manufacturing*. Tinley Park, IL: Goodheart-Willcox, 1993.
Roger, Jr. Harlow. Thompson, Richard. *Principles of Dimensional Metrology.* Delmar Publishers, 1998.
Groover, Mikell P. *Principles of Modern Manufacturing: Materials, Processes, and Systems.* John Wiley and Sons, 2001.
Krar, Stephen F. Rapisarda, Mario. Check, Albert F. Krar, Steve. *Machine Tool and Manufacturing Technology.* Delmar Publishing, 1997.
Kibbe, Richard R. Neely, John E. Meyer, Roland O. White, Warren T. *Machine Tool Practices*. Prentice Hall, 1998.
Neely, John E. *Basic Machine Tool Operations.* Prentice Hall, 1999.
Amrine, Harold. Ritchey, John. Moodie, Colin. Kmec, Joseph. *Manufacturing Organization and Management.* Prentice Hall, 1992.